TIII:

Series Resonant Circuits

Unclassified

3 Hour Conference, W/ 3Hr PE1

Safety & Environmental Impact is “LOW”

TIII: **Series Resonant Circuits**

Terminal Learning Objective

Action: **Given questions, Calculate Bandwidth, 1/2 Power Point, f1 & f2, Quality and Resonance. Also answer questions pertaining to operational characteristics of the Band Pass & Reject Filters.**

Condition: **White OMEMS Training Aid.**

Standard: **70% Minimum.**

Introduction

This lesson is much like LCR Ckt covered in the AC block, this lesson refines and adds additional concepts to what you have learned previously. The concepts acquired in this lesson will be helpful in the comprehension of the circuits that will follow in subsequent lessons.

TIII: SERIES RESONANT CIRCUITS

Terms & Formulas; Reference, White Gov Tng Aid.

1. The Frequency were the XL = XC is called Resonance.
2. Opposition [Z] to Current Flow is Minimum.
3. Current Flow is Maximum.
4. @ Resonance the LC acts like a short.
5. Above Resonance the Ckt behaves Inductive.
6. Below Resonance the Ckt behaves Capacitive.
7. **RESONANCE**; $1/ 2\pi \sqrt{LC}$, $L \times C = \sqrt{X} \Rightarrow X\ 6.28 = 1/X \Rightarrow FR$
8. **BANDWIDTH**; BW = f2 – f1
9. **½ POWER POINT**; PK Voltage X .707
10. **QUALITY**; $Q = F_R/BW$
11. BANDPASS; Output across the Resistor, LC act like a Short. Passes all, from f1 to f2 inclusive of Resonant Frequency.
12. BANDREJECT; Output across the LC, Shorts Signal to Gnd. Rejects all, from f1 to f2 inclusive of Resonant Frequency.

Reactance

TIII: SERIES RESONANT CIRCUITS

Reactance;

Finding Reactance; X

Inductive Reactance; X_L $2\pi FL = X_L$

6.28 X Freq X Inductor = X_L in Ω

Capacitive Reactance; X_C $1/2\pi FC = X_C$

6.28 X Freq X Cap 1/X = X_C in Ω

Impedance; Z $\sqrt{R^2 + [X_L - X_C]^2}$

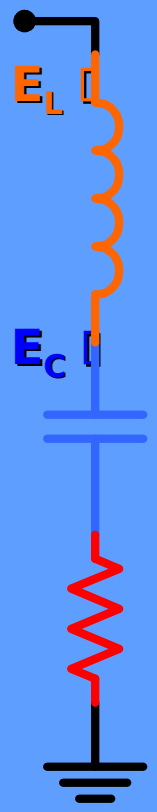
X_L - X_C = X^2 + R X^2 = √ X = Z in Ω

X & Freq

TIII: SERIES RESONANT CIRCUITS

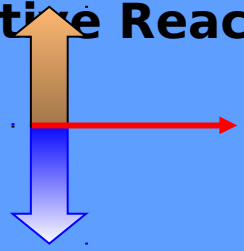
Reactance & Frequency;

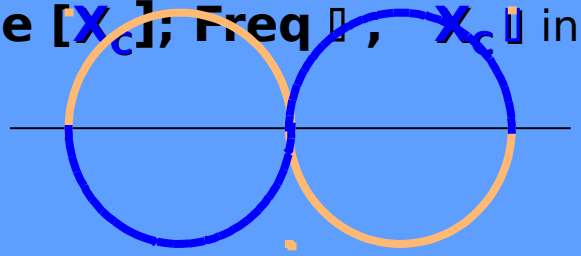
Relationship;



Inductive Reactance [X_L]; Freq ⇑, X_L ⇑ in Ω,

Capacitive Reactance [X_C]; Freq ⇑, X_C ⇓ in Ω,



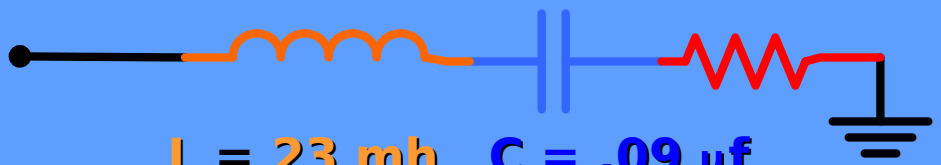


When the E_L & E_C are <u>equal</u> they will cancel each other out. The LC portion will "act" like a Short.

Resonance

TIII: SERIES RESONANT CIRCUITS

Resonance; Determined by the Value of the Inductor & Cap



L = 23 mh C = .09 μf

$$\frac{1}{2\pi\sqrt{\frac{L}{C}}\,X} = F_R$$

23 EE -3 X .09 EE -6 = $\sqrt{\ }$ X ⇒ X 6.28 = 1/X 2nd 6 ⇒ 3.499 KHz

Note:

White Gov Tng Aid. Back, panel; F

Challenge

TIII: SERIES RESONANT CIRCUITS

Resonance; Calculate the Resonant Frequency $F_R = \frac{1}{2\pi\sqrt{L X C}}$

A.	B.	C.
L = 2 mh	L = 10 mh	L = 50 h
C = .05 μf	C = .05 μf	C = .03 μf
F_R = ____	F_R = ____	F_R = ____

L X C = $\sqrt{X}$ ⇒ X 6.28 = 1/X 2nd 6 ⇒ F_R

Answers

TIII: SERIES RESONANT CIRCUITS

Resonance; Calculate the Resonant Frequency $F_R = \frac{1}{2\pi\sqrt{L X C}}$

A.	B.	C.
L = 2 mh	L = 10 mh	L = 50 h
C = .05 μf	C = .05 μf	C = .03 μf
F_R = 15.923 KHz	F_R = 7.121 KHz	F_R = 130 Hz

L X C = $\sqrt{X}$ ⇒ 7.121 KHz = 1/X 2nd 6 ⇒

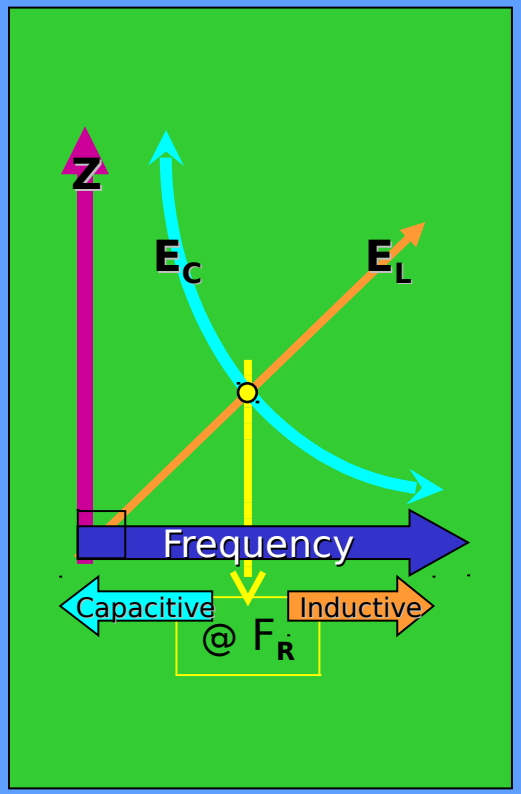
F_R

Chart

TIII: SERIES RESONANT CIRCUITS

Chart; Voltage current Relationship

Ref; White Tng Aid, Panel **F**



↓ F_R	@ F_R	↑ F_R
XC > XL	XL = XC	XL > XC
EC > EL	EL = EC	EL > EC
I ↓	I is Max	I ↓
Z ↑	Z is Min	Z ↑
Capacitive	Resistive	Inductive

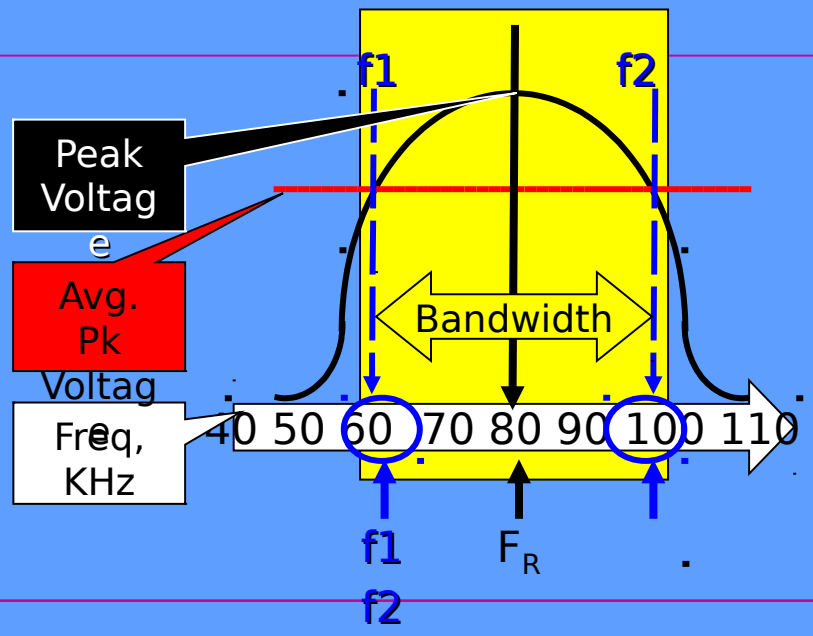
Bandwidth

TIII: SERIES RESONANT CIRCUITS

Bandwidth;

Ref; White Tng Aid, Panel **G**

Bandwidth describes those frequencies that a tuned Ckt, dependant on the Value of the reactive devices, is responsive to and will display the average Pk Voltage amplitude on the output between f1 & f2 frequencies. **BW = f2 – f1**



f2 – f1 = BW

100 - 60 = 40 KHz

The BW frequencies is 60 to 100 KHz

The Avg. Pk Voltage is Known as the

½ Power Point

½ Pwr Pt

TIII: SERIES RESONANT CIRCUITS

½ Power Point;

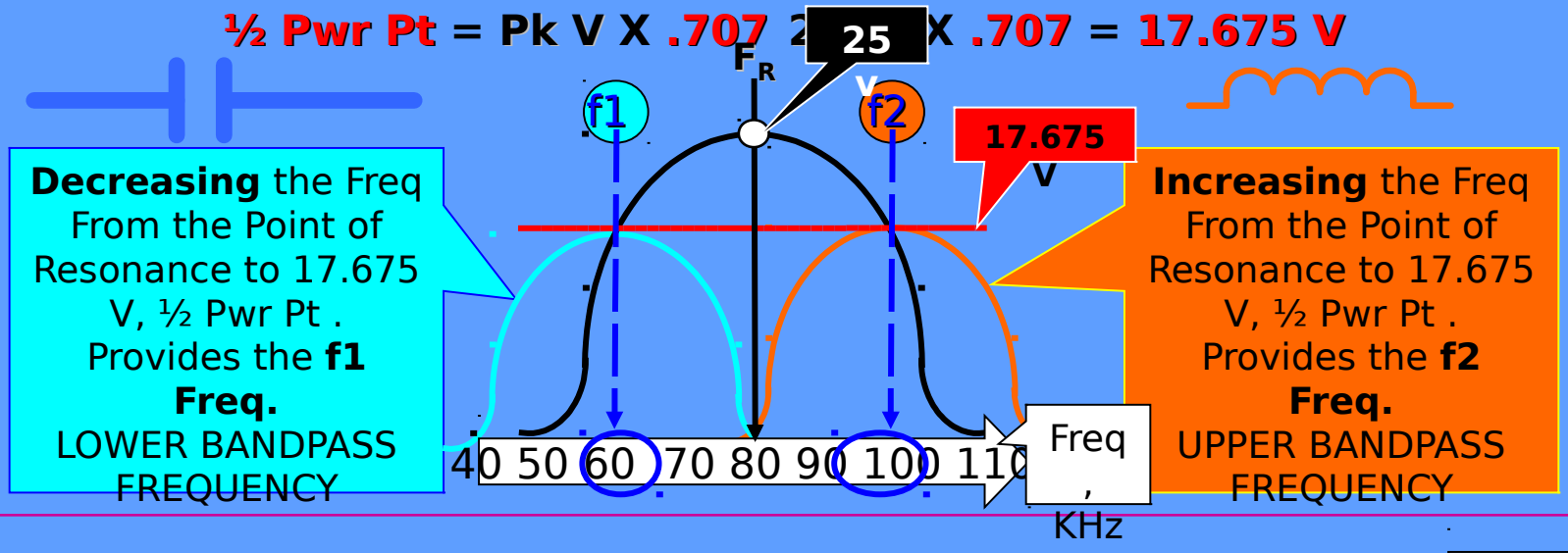
Ref; White Tng Aid, Panel **G**

½ Power Point describes the Avg. Pk voltage of the BW.

f1 Frequency; As the Freq is ↓ signal V ↓ to 70.7% of the Pk V.

f2 Frequency; As the Freq is ↑ signal V ↓ to 70.7% of the Pk V.

½ Pwr Pt = Pk V X .707 25 X .707 = 17.675 V



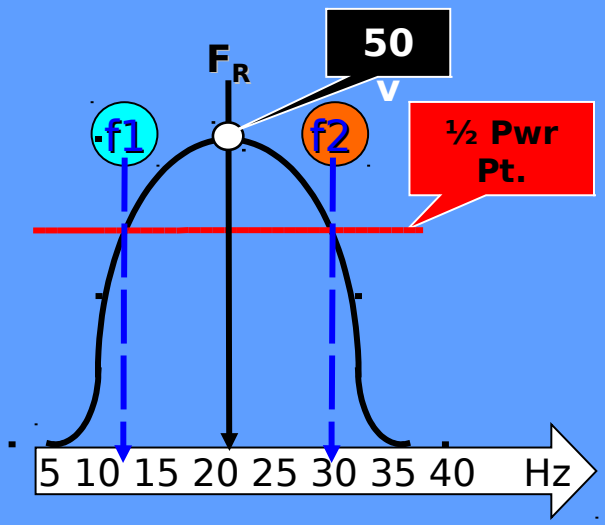
Decreasing the Freq From the Point of Resonance to 17.675 V, ½ Pwr Pt . Provides the **f1 Freq.** LOWER BANDPASS FREQUENCY

Increasing the Freq From the Point of Resonance to 17.675 V, ½ Pwr Pt . Provides the **f2 Freq.** UPPER BANDPASS FREQUENCY

Challenge

TIII: SERIES RESONANT CIRCUITS

Determine the following Ckt Parameters.



F_R = ____

½ Pwr Pt = ____

f1 = ____

f2 = ____

BW = ____

Q = ____

Q Describes the selectivity of the Ckt. A High Q, a Increased Selectivity. A Low Q, a Decreased Selectivity. Sometimes referred to as the Quality of the Ckt.

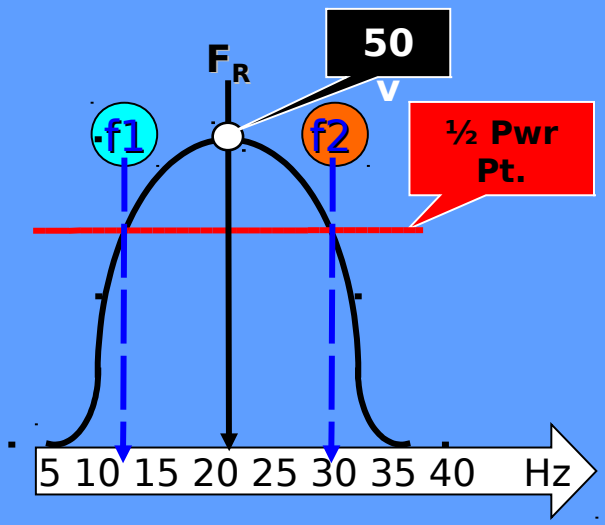
$$Q = \frac{FR}{BW}$$

Ref; White Tng Aid, Panel **G**

Answers

TIII: SERIES RESONANT CIRCUITS

Determine the following Ckt Parameters.



F_R = 20 Hz

½ Pwr Pt = 35.35 V

f1 = 10 Hz

f2 = 30 Hz

BW = 20 Hz

Q = 1

Q Describes the selectivity of the Ckt. A High Q, a Increased Selectivity. A Low Q, a Decreased Selectivity. Sometimes referred to as the Quality [illegible]

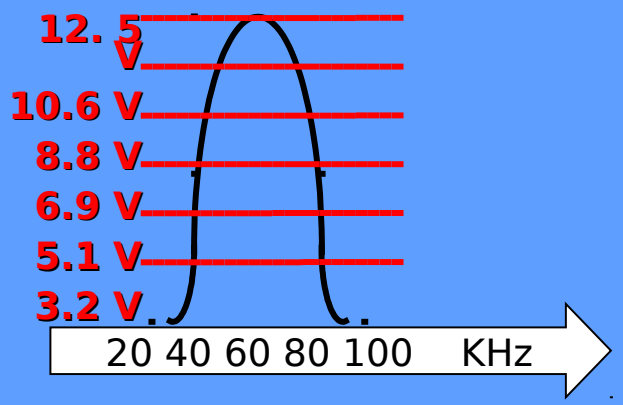
$$Q = \frac{FR}{BW}$$

Ref; White Tng Aid, Panel **G**

Challenge 2

TIII: SERIES RESONANT CIRCUITS

Determine the following Ckt Parameters.



EF_R = _____

F_R = _____

½ Pwr Pt = _____

f1 = _____

f2 = _____

BW = _____

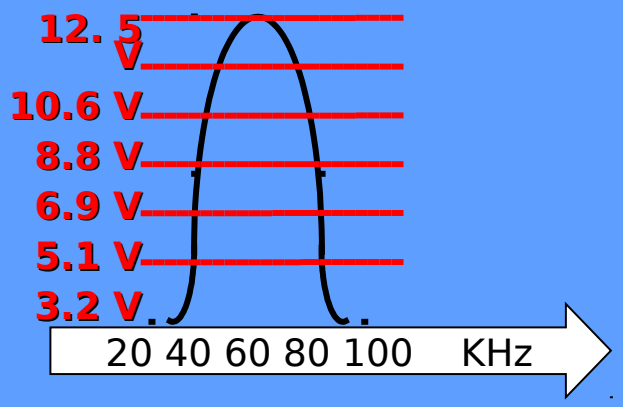
Q = _____

Ref; White Tng Aid, Panel G

Answers

TIII: SERIES RESONANT CIRCUITS

Determine the following Ckt Parameters.



EF_R = 12.5 V

F_R = 60 KHz

½ Pwr Pt = 8.8 V

f1 = 40 KHz

f2 = 80 KHz

BW = 40 KHz

Q = 1.5

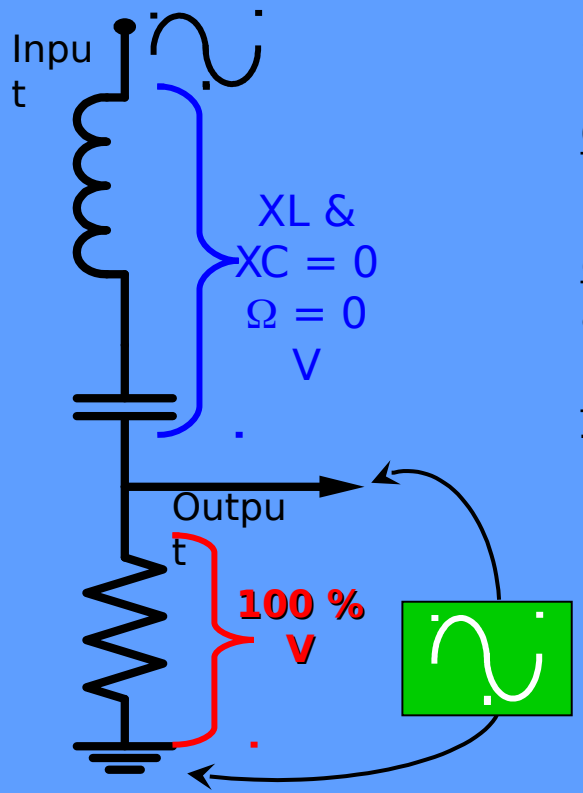
Ref; White Tng Aid, Panel G

Band Pass Filter

TIII: SERIES RESONANT CIRCUITS

Series Band Pass Filter;

Ref; White Tng Aid, Top Left Panel E

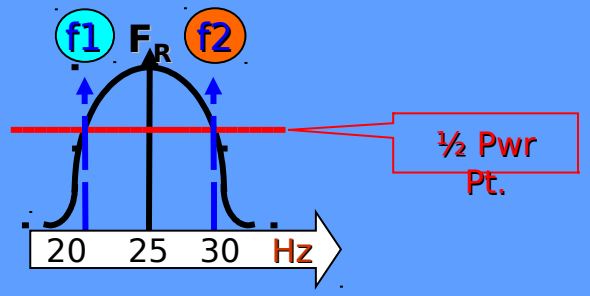


Series Band Pass Filter;

Output; Taken across the resistor, in ref. to Gnd.

@ Resonance; The LC portion acts like a Short.

Passes; All Frequencies from f1 to f2 inclusive of the Resonance Freq.

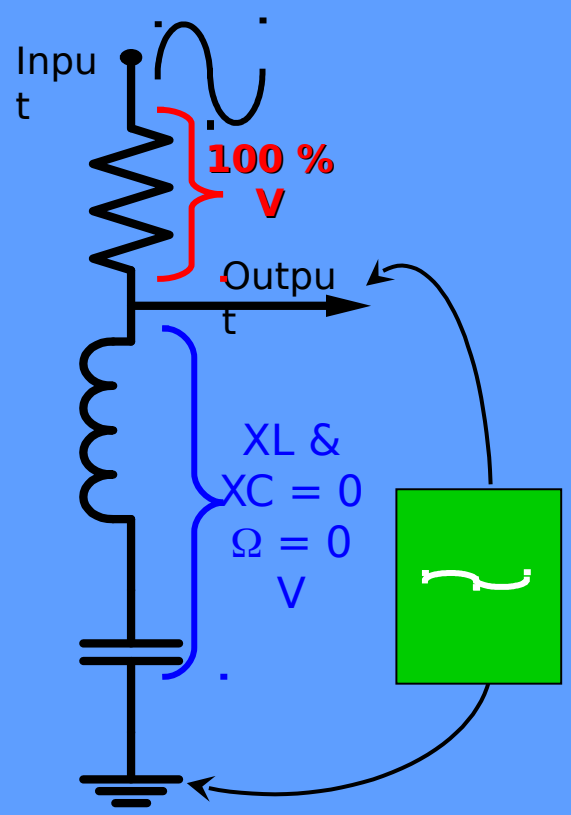


Band Reject Filter

TIII: SERIES RESONANT CIRCUITS

Series Band Reject Filter;

Ref; White Tng Aid, Top Left Panel E

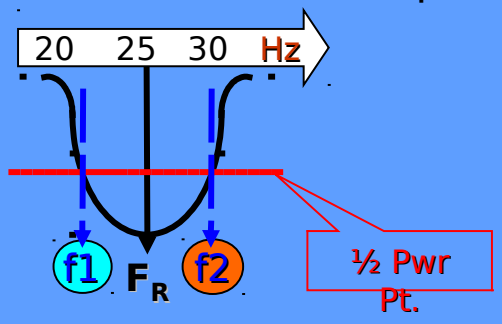


Series Band Reject Filter;

Output; Taken across the LC, in ref. to Gnd.

@ Resonance; The LC portion acts like a Short.

Rejects; All Frequencies from f1 to f2 inclusive of the Resonance Freq.



Problem Sheet

TIII: SERIES RESONANT CIRCUITS

Problem Sheets; 10 Problems

1. Calculate Resonance Frequency for each of the following LC values.

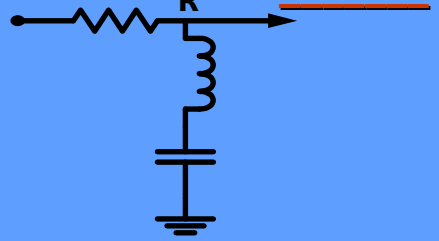
a. **C = .005 μf** **L = 200 mh** **F_R = _____**

b. **C = .02 μf** **L = 600 mh** **F_R = _____**

c. **C = .04 μf** **L = 400 mh** **F_R = _____**

d. **C = .001 μf** **L = 20 mh** **F_R = _____**

e. **C = .09 μf** **L = 10 mh** **F_R = _____**



2. What type of Filter is illustrated?

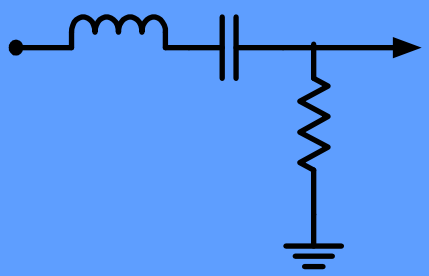
_____

Answers 1 & 2

TIII: SERIES RESONANT CIRCUITS

Problem Sheets; 10 Problems,

3. What type of Filter is illustrated?



_____

4. Below the FR a series LCR filter Acts _____ .
5. Above the FR a series LCR filter Acts _____ .
6. @ FR Current is _____ in an LCR Ckt.
7. @ FR Impedance is _____ in an LCR Ckt.

Answer 3-7

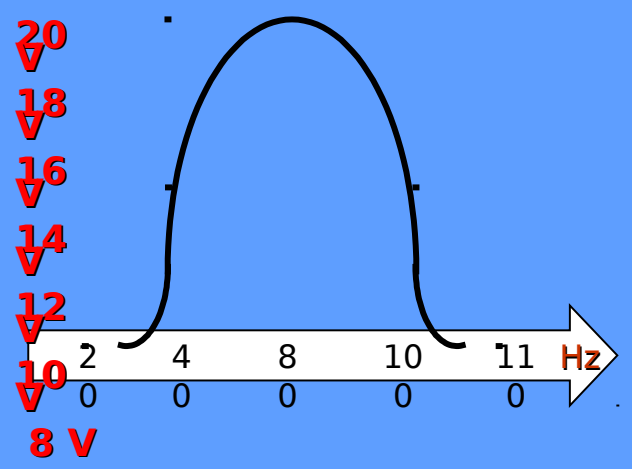
TIII: SERIES RESONANT CIRCUITS

Problem Sheets; 10 Problems,

Note; For Question 8-10 calculate the operating parameters using the associated illustration and the ½ Pwr point for the f1 & f2 frequency's.

8.

a. F_R _____
b. 1/2 Pwr Pt V _____
c. f2 _____
d. f1 _____
e. BW _____
f. BW Frequencies _____
g. Q _____



Answer 8

TIII: SERIES RESONANT CIRCUITS

Problem Sheets; 10 Problems,

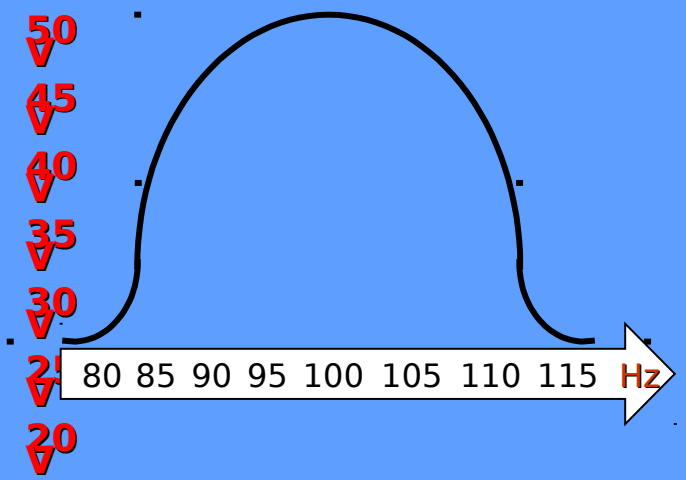
Note; For Question 8-10 calculate the operating parameters using the associated illustration and the ½ Pwr point for the f1 & f2 frequency's.

9.

a. F_R _____
b. 1/2 Pwr Pt V _____
c. f2 _____
d. f1 _____
e. BW _____
f. BW Frequencies

_____

g. Q _____



Answer 9

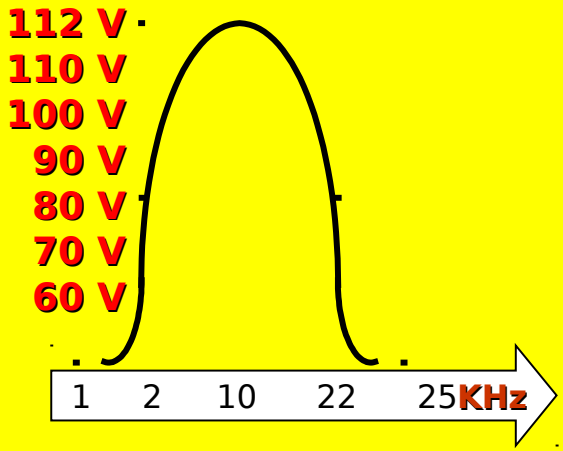
TIII: SERIES RESONANT CIRCUITS

Problem Sheets; 10 Problems,

Note; For Question 8-10 calculate the operating parameters using the associated illustration and the ½ Pwr point for the f1 & f2 frequency's.

10.

a. F_R _____
b. 1/2 Pwr Pt V _____
c. f2 _____
d. f1 _____
e. BW _____
f. BW Frequencies _____
g. Q ____



Answer 10

TIII: SERIES RESONANT CIRCUITS

Lesson Test;

Lesson Test:

Standard: 10 Questions W/in 20 Minutes. 70% Minimum Accuracy. Reference: White OMMCS Tng Aid.

$L \times C = \sqrt{X} \Rightarrow X \; 6.28 = 1/X \; 2^{nd} \; 6 \Rightarrow F_R$

Close